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VOLUME IV
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Interim Response Action
Basin F Liquid Incineration Project

FINAL DRAFT

HUMAN HEALTH RISK ASSESSMENT

(COMMENTS AND RESPONSES FROM EPA, ITO AND THE STATE OF COLORADO TO THE DRAFT HUMAN HEALTH RISK ASSESSMENT, JANUARY 1991)

Volume IV

Preplaced Remedial Action Contract
Contract No. DACW-45-90-D-0015

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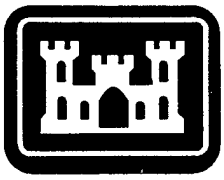

U.S. Army Corps
of Engineers
Omaha District

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13. ABSTRACT *(Maximum 200 words)*

THIS DOCUMENT IS A COMPREHENSIVE, MULTIPLE EXPOSURE PATHWAY, HUMAN HEALTH RISK ASSESSMENT PREPARED FOR THE PROPOSED BASIN F LIQUID INCINERATION PROJECT. THE SUBMERGED QUENCH INCINERATOR WILL TREAT BASIN F LIQUID AND HYDRAZINE RINSE WATER. THE OBJECTIVE OF THE RISK ASSESSMENT IS TO ESTABLISH CHEMICAL EMISSION LIMITS WHICH ARE PROTECTIVE OF HUMAN HEALTH. AVERAGE AND MAXIMUM LIFETIME DAILY INTAKES WERE CALCULATED FOR ADULTS, CHILDREN, AND INFANTS IN FOUR MAXIMUM EXPOSURE SCENARIOS UNDER BASE CASE AND SENSITIVITY CASE EMISSIONS CONDITION. IT WAS CONCLUDED THAT THE INCINERATION FACILITY POSES NEITHER CARCINOGENIC NOR NONCARCINOGENIC RISK TO ANY SENSITIVE POPULATION.

THE ASSESSMENT IS DIVIDED INTO THE FOLLOWING SECTIONS:

1. INCINERATION FACILITY DESCRIPTION
2. DESCRIPTION OF SURROUNDING AREA
3. PROCESS OF POLLUTANT IDENTIFICATION AND SELECTION
4. DETERMINATION OF EMISSION RATES FROM INCINERATION FACILITY

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PROGRAM MANAGER FOR ROCKY MOUNTAIN ARSENAL COMMERCE CITY, COLORADO

INTERIM RESPONSE ACTION BASIN F LIQUID INCINERATION PROJECT

FINAL DRAFT HUMAN HEALTH RISK ASSESSMENT RESPONSES TO COMMENTS ON THE DRAFT HUMAN HEALTH RISK ASSESSMENT FROM EPA, ITO, AND STATE OF COLORADO

VOLUME IV

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RMA REVISED VOLUME IV

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SECTION 1

RESPONSE TO COMMENTS FROM EPA ON THE DRAFT HUMAN HEALTH RISK ASSESSMENT (JANUARY 1991) FOR ROCKY MOUNTAIN ARSENAL INCINERATION PROJECT

GENERAL COMMENTS

Comment No. 1: The overall scope of the HHRA is complete and the presentation is generally clear; however, some of the premises upon which the assessment is based contradict current EPA risk assessment guidance and a substantial number of details in the document are inaccurate or unclear. The extent to which the correction of these deficiencies will affect the final conclusions of this assessment cannot be determined until the deficiencies are corrected. Although several major items are discussed in this review, it is likely that minor items were missed and it is assumed that further QC of this document will occur before it becomes final.

Response: The Army has closely coordinated the development of this HHRA with EPA. This type of coordination and use of technical working meetings will continue. The revised draft protocol is provided as an attachment.

Comment No. 2: The key concept in EPA's Risk Assessment Guidance for Superfund (RAGS) is the concept of Reasonable Maximum Exposure (RME). This concept was developed in order to avoid the simultaneous use of "average" and "maximum" exposure scenarios. The development and calculation of RME chemical concentrations for contaminated media is clearly stated in RAGS (upper 95% confidence limit of the mean). Although some of the language pertinent to the RME concept was used in this assessment, the concept was not actually applied. In addition, much of the language applied to the various scenarios would be quite confusing for a risk manager trying to determine whether or not an "average" or "maximum" case is being evaluated (see Specific Comments).

Response: The Army did not evaluate "average" and "maximum" exposure scenarios. The Army evaluated average and maximum doses, based on average and maximum soil concentrations resulting from deposition of projected base case and sensitivity case emissions for the two years of incinerator operation proposed. For each exposure scenario, the average dose (i.e., the average over years 1-70) was used to calculate carcinogenic risk and the maximum dose (i.e., the maximum over years 1-70) was used to calculate non-carcinogenic risk. The basis for this approach is further explained in the Response to Comment on page ES-3. There were an insufficient number of data points with which to calculate an upper 95% confidence level of emissions. For most contaminants, the data consisted of the results of sets of waste analyses, which were presented either as ranges (with

no individual data points) or single data points. The arithmetic means of the midpoints of the ranges and the single data points from one group of data sets (i.e., all analyses for the basin, pond, or tank) were compared and the highest of these values was used as the base case. This approach is believed to be a reasonably conservative method of calculating a conservative upper bound of continuous (long term) emissions in lieu of calculating an upper 95% confidence level of emissions. The results of test burns were also considered in the development of emissions: however, insufficient acceptable data points were available to calculate a 95% confidence level. Because maximum air and deposition modeling factors were also used in determining exposure, the overall estimate of exposure is expected to be conservative (i.e., represent a greater than average exposure), although the confidence level cannot be determined based on available data. This will be more clearly stated in the next draft of the report. It should also be noted that EPA's Risk Assessment Guidance for Superfund (RAGS), in the discussion of Reasonable Maximum Exposure (RME), does not specifically address exposure to combustor emissions. An additional EPA document that was consulted was:

> "Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions" (January 1990, EPA/600/6-901003).

Comment No. 3: The toxicity assessment and risk characterization for lead (Pb) is not handled in accordance with current EPA Region VIII policy for evaluating lead exposure. Please contact Dr. Chris Weis (Region VIII Superfund Toxicologist) for guidance regarding this subject.

Response: The lead biokinetic model was believed to be inappropriate to use for this project since the model is still being reviewed and validated by EPA. We recently spoke to Dr. Chris Weis and he agreed that the lead biokinetic model should not be used for this site. However, he suggested that we compare estimated lead soil concentrations for RMA and vicinity to the recommended soil clean-up level for total lead of 500-1000 mg/kg (based on OSWER directive #9335.4-02). This comparison will be included in the next draft of the risk assessment, and our current evaluation of lead (i.e., comparison to an RfD) will be omitted. In addition, we will compare estimated lead air concentrations to the NAAQS for lead. It should also be noted that even though we are evaluating lead through the soil pathway, estimated soil lead concentrations are very low and would have been screened out based on 1% of background. However, lead was included for evaluation because of current concerns regarding exposure of children to low lead levels.

Comment No. 4: Given the considerable amount of soils data collected at RMA, the use of background soils data from DOE's Rocky Flats facility as a screening tool for eliminating some metals from consideration in this assessment does not seem justified.

Response: We attempted to obtain site-specific soils data from appropriate agencies but were unable to find site-specific background data. It has recently come to our attention that

background data are available for off-post and on-post locations. These will be incorporated into the document upon receipt of the data.

Comment No. 5: There are several instances in the HHRA where reference is made to documents developed as part of the RMA On-Post and Off-Post risk assessments. Both of these assessments are currently on-going with many risk assessment issues still being debated by EPA and DOA. This assessment suggests that these reports are final and that certain issues have been decided and agreed upon by EPA which is not the case.

Response: All references to these documents will be modified to indicate the current status at the time of the final HHRA.

Comment No. 6: It is difficult to follow the derivation of destruction efficiencies as presented by Dellinger in Appendix 5B. We were unable in several cases to duplicate Mr. Dellinger's results of 99.99%. This needs to be rectified.

Response: The 9 April 1991 conference call with Dr. Dellinger (telephone conversation report included as Section 5 of this report) satisfactorily answered all questions concerning his methodologies. The Army was able to verify Dr. Dellinger's calculations by reproducing the results.

SPECIFIC COMMENTS

Page ES-3, Last Paragraph: A single RME estimate of daily intake should be used for each receptor for each scenario, not average and maximum.

Response: "Average" and "maximum" refer to the average and maximum concentrations that were calculated for soils. In evaluating exposure through soil-mediated exposure routes, one has to take into account that soil concentrations change during the deposition period (i.e., the facility lifetime) due to continued deposition and in some cases, degradation. Changes in soil concentrations of some compounds due to degradation are normally addressed for those organic compounds for which half-life data are available. However, based on an agency request, degradation of organics was not assumed in this risk assessment. The average soil concentration that was calculated is an average of the soil concentrations expected from years 1 through 70, but is still a maximum value in that it is based on the deposition at the location of maximum predicted impact and conservative estimates of emissions. It is necessary for us to calculate these average soil concentrations because carcinogenic risk is calculated based on a lifetime of exposure, and it is not logical to assume that an individual is exposed to the maximum soil concentration (which first occurs at the end of year 2) for 70 years. This application of average and maximum is different than the average and upper 95% confidence limit of the mean referred to in RAGS. It should be noted that since degradation of organics was not evaluated in this risk assessment, the average and maximum soil concentrations calculated over a 70-year period are very similar, and only differ by a factor of approximately 1 to 2%.

For air, average and maximum concentrations do not need to be calculated since during the two years of exposure to air emissions, the air concentrations remain constant based on an assumed constant emission rate. For surface water, exposure doses are based on the maximum concentrations following the 2-year combustor life. The more conservative maximum concentration is used since a 70-year average concentration would be technically difficult to calculate.

Page ES-5, First Paragraph: Difference between A and B should be explained more clearly.

Response: As described in Subsection 8.1.1, Resident A is assumed to be living in a residential area at which off-site dry deposition and ambient air concentrations are maximal. This area falls outside the arsenal boundaries (off-site) since individuals are not permitted to live on the grounds of the arsenal. The maximum off-site dry deposition and air concentrations occur at the same location, directly north of the arsenal. Resident B is assumed to be living in a residential area at which off-site wet (and total) deposition is maximal. As with the Resident A scenario, Resident B is assumed to be living off-site. The Resident B location falls directly south of the arsenal. These differences between Resident A and Resident B will be described more clearly in the Executive Summary (Volume I).

Page ES-5, Last Two Paragraphs: In one sentence, "base case" is defined as "average expected" while in another sentence "base case" is defined as "conservative upper bound estimates of continuous operating conditions." Precise, quantitative, and consistent definitions of these terms are needed throughout the document.

Response: The base case should not have been referred to as "average expected." This sentence will be modified. Also, "conservative upper bound estimates of continuous operating conditions" should read "conservative estimates of continuous, long-term operating conditions." The document will be modified to ensure that no other inconsistencies in definitions exist.

Page ES-9, Third Paragraph, First Sentence: How does this relate to the RME as defined by EPA in RAGS?

Response: The sensitivity case reflects a worst case of continuous long term emissions or the peak variability in short-term emissions. Short-term emission rates would not be appropriate to use in evaluating the RME, since continuous exposure is assumed for the RME. However, the sensitivity case is appropriate for assessing acute exposure or uncertainty regarding the upper bound of chronic exposure.

Page ES-12, First Bullet, Line 5: Change "subchronic" to "chronic."

Response: Comment will be addressed.

Page 1-2, First Paragraph, First Sentence: Change "have been" to "are currently being."

Response: Comment will be addressed.

Page 1-2, First Paragraph, Last Sentence: Cite specific references and note that several assumptions, parameters, etc., are still being evaluated.

Response: Comment will be addressed.

Page 5-1, Section 5.2: As stated previously, a single RME approach should be used to estimate emission rates.

Response: As stated previously, the base case emission rates used in the report are believed to be reasonably conservative estimates of continuous emissions in lieu of calculating an upper 95% confidence level of emissions (see response to General Comment No. 2). The

sensitivity case emission rates are estimates of worst case continuous long-term or of short-term operating conditions and were only evaluated as part of the sensitivity analyses.

Page 5-3, Middle Paragraph, Last Sentence: If the sensitivity scenario is supposed to be "worst case," why would emission rates be based on "average" values. This is misleading.

Response: As noted in Subsection 5A.4.2, the sensitivity case emissions estimates for metals and organics were chosen in the draft analysis from the maximum of the following values:

- The average of all test runs during the test burn.
- The maximum controlled emission rate based on the waste feed data.
- The maximum EPA Tier II values (no longer considered in the revised analysis).

The average of the test runs was considered rather than the test run with the highest value because EPA emissions testing methods specify that emission test results should be calculated as the average of at least three replicate test runs in a test series. Although a number of the test runs would not have been considered acceptable for emission factor development because of abnormal conditions during testing, and thus were not considered in the base case, they were considered in the development of the sensitivity case. Because the aforementioned sensitivity case emissions were chosen from the maximum of the three types of values listed above, the sensitivity case can be characterized as a worst case estimate.

Page 7-5, Middle Paragraph, Third Sentence and Page 9-14, Section 9.4.2.2 (Last Sentence): On Page 7-5, it is stated that the total mass of each pollutant is assumed to be in the vapor phase, yet on Page 9-14, it is stated that the inhalation RfD was adjusted for the fraction of inhaled particles by dividing the oral RfD by 75%. If the pollutant is all in the vapor phase, why make the adjustment?

Response: In the first sentence "available for inhalation" and "available for deposition" needs to be deleted. The third sentence should be changed to read "similarly, for the inhalation pathway, the total mass of each pollutant emitted is assumed to be available for inhalation." In deriving the inhalation RfD, the oral RfD was adjusted to make it consistent with the oral to inhalation route extrapolation that EPA used in deriving the inhalation slope factor.

Page 7-10, Table 7-2: See General Comment No. 4. Also, "Barium" needs the "d" superscript.

Response: See response to General Comment No. 4. A "d" superscript will be placed after "barium."

Page 7-13, Table 7-3: Why is beryllium on this table if the emissions are reported as "0.00" on Table 7-2? Based on Table 7-2, thallium should also be on this table.

Response: In Table 7-2, the "2-year soil concentration due to incinerator emissions" for beryllium should be "0.001." The "soil concentration: mean background ratio" for beryllium should be "0.02." These changes will be made. Also, in Table 7-3, thallium will be placed under "inorganics."

Page 7-16, Section 7.6, Second Paragraph: See General Comment No. 3. Breast milk pathway is included in the Integrated Uptake/Biokinetic Model currently used by EPA Region VIII.

Response: As stated previously, the Integrated Uptake/Biokinetic Model was felt to be inappropriate to use at this site (see response to General Comment No. 3). Dr Chris Weis (Region VIII Toxicologist) also agreed that the model should not be used at this site.

Page 8-1, Section 8.1.1, Second and Third Sentences: The RME approach referred to here is not actually applied in this assessment. In addition, the first sentence in Subsection 8.1 actually conflicts with the RME approach.

Response: The RME approach, as defined by EPA in RAGS, is guidance for Superfund sites. We have modified this approach as described for Superfund sites because of the lack of sampling data and because of the additional variables applicable to incinerator sites that need to be considered (see responses to General Comment No. 2 and Page ES-3). However, we are still evaluating reasonably maximally exposed individuals. In the first sentence of Subsection 8.1, "average expected" will be eliminated and the statement will be revised to clarify the distinctions between the RME approach, which could not be used, and the approaches that were used.

Page 8-2, Lines 2-3: The four RME scenarios developed in this assessment do not fit the quantitative definition of RME in the EPA RAGS document.

Response: As discussed in Subsection 8.1.1, four scenarios were evaluated because it is not possible to predict which of the scenarios will pose the highest risk until risk numbers are generated. Where appropriate, guidance from the RAGS manual was used.

Page 8-5, Second Sentence: Land use classifications would be a more appropriate selection method.

Response: Based on discussions with local agricultural agencies, it was believed that it would be highly unlikely for new farms to be started in the RMA vicinity, since the area

around RMA, is becoming increasingly developed. The new airport, which is going to be built to the east of RMA, will add to the development that is occurring in the area. It seemed, in this case, to be more realistic to locate a farm based on observations of current land use rather than to use general land use classifications.

Page 8-5, Middle Paragraph, Last Sentence: How do the "area-weighted total deposition rates and air concentrations" relate to RME concentrations as defined by EPA in RAGS?

Response: Because workers are exposed to emissions close to the facility, it is possible that they are the reasonably maximally exposed individuals even though they are potentially exposed to contaminants through fewer exposure routes. Because the workers perform their duties on the entire site, the exposure concentration was calculated based on site area-weighted deposition data and air concentrations. As stated in the response to General Comment No. 2, the emissions data used in these calculations are based on conservative estimates of emissions.

Page 8-5, Last Paragraph, Second Sentence: As mentioned previously, calculating exposure concentrations using base case (average) emission rates is not consistent with EPA guidance regarding RME concentrations.

Response: As stated previously, the base case emission rates are believed to be reasonably conservative estimates of emissions in lieu of calculating an upper 95% confidence level of emissions (see response to General Comment No. 2).

Page 8-8, Middle Paragraph, Fourth Sentence: This sentence is a non sequitur and does not justify using average soil values.

Response: This sentence should be changed to read "The average soil concentrations over the 70-year exposure period were used in calculating carcinogenic risk through all soil-mediated pathways based on exposure as a child and as an adult since the calculation of carcinogenic risk is based on a 70-year lifetime exposure." The sixth sentence should also be changed to read "In order to prevent underestimating carcinogenic risk based on exposure as an infant..." Also, as stated previously, the average soil concentration is calculated as an average of the soil concentrations expected from years 1 through 70, but is still a maximum value in that it is based on the maximum modeling deposition factor and conservative estimates of emissions.

Page 8-8, Middle Paragraph, Second to Last Sentence: Wouldn't this statement be true for carcinogens as well?

Response: No. Cancer risk is calculated based on exposure doses averaged over a lifetime. It is unrealistic to assume that an individual is exposed for 70 years to a soil concentration that occurs only at the end of year 2. For this reason, an average of the concentrations from years 1 through 70 is used in estimating carcinogenic risk. Chronic RfDs, used in evaluating noncarcinogenic risk, apply to exposure periods of 7 years or greater. It is possible that an individual may be exposed to concentrations close to the maximum soil concentrations for a 7-year period. To simplify the evaluation of noncarcinogenic risk, the maximum soil concentrations were conservatively used.

Page 8-52, Worker Soil/Dust Ingestion Rate: EPA recommends using 100 mg/day for the adult soil ingestion rate for all scenarios (see Volume VII, Page 4-4 of the referenced document).

Response: A 100 mg/day soil ingestion rate will be used for the worker.

Page 9-10, No. 3, Last Sentence: The "RfD" for lead has not been approved by EPA and alternative methods for evaluating lead exposure are currently employed by Region VIII (see General Comment No. 3). In addition, none of the other "derived RfDs" have been approved by EPA for use in other contexts.

Response: See response to General Comment No. 3. It was stated in the protocol that derived toxicity values would be used when established values were unavailable, subject to approval by U.S. EPA Region VIII and CDH (Subsection 3.3 of the attached protocol). The derivations of RfDs were provided in the report, so that on review of the report, EPA and CDH could judge whether the RfDs are acceptable.

SECTION 2

RESPONSE TO COMMENTS FROM ITO (FLUOR DANIEL) ON THE DRAFT HUMAN HEALTH RISK ASSESSMENT (JANUARY 1991) FOR ROCKY MOUNTAIN ARSENAL INCINERATION PROJECT

GENERAL COMMENTS

Comment No. 1: Suggest putting all references at the end of the document instead at the end of each section.

Response: References will be put together at the end of the document, but will still be broken out by section.

Comment No. 2: All data referred to in this report should be referenced and/or included as appendices. It is preferable to list all assumptions in the main body of the text.

Response: All data in the report will be referenced. Any data placed in an appendix will be referenced in the main text.

Comment No. 3: All formula or calculations should be presented in the text with a formula number. If formulas are presented in appendices, then all main text references should be by formula number.

Response: Formulas presented in the appendices and used in the text will be referenced by appendix, section, and page number.

Comment No. 4: I found it very difficult to trace numbers from one section to another and from the appendices. Decisions and selections are made and the criteria for these selections are buried in the appendices. Often, the topics are not presented in sequential order. As stated in comment 29, all presentations of data, formulas, and tables should be in the main text. A suggested outline is as follows: ...

Response: The order of presentation of the information will not change. However, the document will be modified to make it more clear and to ensure all data are correctly referenced.

Comment No. 5: For ease of viewing and perhaps maybe reduce table size, once the selection of key pollutants has been made, delete all non selected chemicals.

Response: All of the chemicals will be followed through the risk assessment. Chemicals will not be deleted from the tables.

SPECIFIC COMMENTS

Page 1-2 1st Bulleted Paragraph: The latest guidance from the RAGS states that the Representative Maximum Exposure (RME) is to be used for exposure parameters including environmental concentrations. This is defined as the 95% Upper Confidence Limit (UCL) of the arithmetic mean. The use of the average and/or the worst case is no longer applicable.

When relatively few data points are available (usually five or less), it may be appropriate to use the maximum value as the RME.

When only single points are available (such as from modeling results) it may be appropriate to use the single point plus the estimated standard deviation of the model output or the upper 95% confidence point.

Regardless of which approach or deviation from the guidelines is used, the approach should be documented. Apparently, some of this is documented in Appendix 6A on p. 6A-20.

Response: There was an insufficient number of data points with which to calculate an upper 95% confidence level of emissions. For most contaminants, the data consisted of the results of waste analyses, which were presented either as ranges (with no individual data points) or single data points. The arithmetic means of the midpoints of the ranges and the single data points from one group of data sets (i.e., all analyses for the basin, pond, or tank) were compared and the highest of these values was used. This approach is believed to be reasonably conservative method of calculating a conservative upper bound of continuous (long-term) emissions in lieu of calculating an upper 95% confidence level of emissions. The results of test burns were also considered in the development of emissions; however, insufficient acceptable data points were available to calculate a 95% confidence level. This approach will be documented and discussed in relation to the guidance provided in EPA's Risk Assessment Guidance for Superfund (RAGS) in the introduction of the document and will be discussed when necessary in other sections of the report so as to avoid reader confusion.

Page 1-6 1st paragraph: Rewrite to include the concept of RME.

Response: The paragraph will be modified to include the concept of RME.

Page 2-8 2nd paragraph: If the stack height has not been determined, then how can air modeling be performed?

Response: The stack height has been finalized at 100 ft. The modeling analysis performed used this as the stack height and has been incorporated into the appropriate parts of Subsections 2 and 6.

Page 3-2 Section 3.2.2: Is it really necessary to put "prohibited" in large bold? Also, the citation for the "Federal Facility Agreement" should be consistent (see citation in 3.3.4).

Response: "Prohibited" will no longer be in large bold. The citation for Federal Facility Agreement will be consistent.

Page 3-1 to 3-9 Section 3.0: It would be helpful to have a map outlining the surface water systems and drainage. This is important because multiple receptor sites are eliminated from further consideration. If these receptors were eliminated through previous risk assessments, then the citations should be clearer. Since many of the water bodies were eliminated because of unlikely deposition patterns, either a source of previous modeling efforts should be cited or a presentation of predicted deposition patterns should be made. See also Specific Comment No. 3.

Response: A surface water map will be included in the report. The isopleth maps (in Section 6) will be referred to in the discussions of the rationale for the selection of Engineers Lake.

Page 3-8 4th paragraph: I did not get the impression from Section 3.3.3 that there was a "significant" drainage impact from RMA to the South Platte River. Also, what is significant? Is it the ratio of water from the site to the river? Or, is it the mass loading of contaminants from the site to the river? See also Comment No. 6 about deposition patterns. Is this a judgement of this assessment or has this been stated in previous assessments?

Response: The sentence that refers to the significant drainage impact from RMA to the South Platte River will be reworded to read "Much of the surface water from RMA eventually drains into the south Platte River."

Page 3-9 Section 3-5: A list of potential pathways with their respective receptors would be helpful at this point. It would provide a check off list for the evaluation of risks. It was noted that in Appendix 6A four exposure scenarios and locations were presented. In addition, previous EPA comments (Comment 7, p 6A-66) that a figure should be included showing these receptor points. It could be a conceptual outline with key physical features, receptor points, and a unit concentration isopleth.

Response: The potential pathways and receptors are presented later in the report in Sections 7 and 8. Any discussions in Section 3 that refer to subsequent sections will reference those sections.

Page 4-1 Section 4.2: A listing of the contaminants in the waste steam and a likely concentration should be presented or referenced (it was found as Table 5A-2) before the discussion of incinerator emissions as well as the test burn data. If not presented in the text,

it could be included and referenced as an appendix. Unless it is in the waste stream, it can't be a POHC. Also, what metals are present in the Basin F liquid? The dioxin data from the test data should be cited. Is there any way to pare this list down based on toxicity, concentration, and destruction efficiency prior to proceeding?

Response: A list of all contaminants in the waste stream with likely concentrations was included in the revised Section 5 and Appendix 5A and was appropriately referenced in Section 4. This will include all metals. The origin of the dioxin data was provided.

Page 4-1 Section 4.2 1st para: Four groups of contaminants were identified here and based on source, but later (also in Appendix 5A, p 5A-1) the grouping is different and based on compound type.

Response: Grouping of the contaminants in Section 4 will be consistent with the grouping in Appendix 5A.

Page 5A-10, Section 5A.3: Was there any other data from the test burn besides dioxins?

Response: Besides the dioxins and metals test burn data that were used in the development of emission factors, the other potential health hazards that were analyzed in the test burn were other trace organics. They were PCBs (mono through deca), aldrin, γ-chlordane, and 4,4-DDT. All of the analyses of these other organics from the test burn were below the detection limits. Therefore, the data could not be used to determine the health-risk associated with these organics from the incinerator.

Page 5A-13, Section 5A.3.3: I do not agree with the use of WESTON's "Database" to provide dioxin emission data for the worst case or maximum emissions. This opinion is based on the fact that the Basin F fluid has a unique composition and is totally unrelated to municipal incinerators and other hazardous waste incinerators. In addition, the SQI incinerator design is not a typical design for most incinerators. It would not be appropriate to use this data for comparison to the test burn data.

Response: The current understanding of dioxin emissions does not allow their estimation based on the composition of a specific waste stream; however, emissions from similar incinerators are generally a reasonable estimate. The "base case" emissions were based on the results of the one acceptable test run during test burns of the Basin F waste. The "sensitivity case" was based upon the maximum of the average of all test runs (acceptable and unacceptable) and the 95% confidence interval of WESTON's database for hazardous waste incinerators only. The 95% confidence interval of the database is also higher than the maximum test run value from the test burn. Therefore, WESTON used the database to estimate a "sensitivity case" or maximum emission rate, that would be conservative

considering both the available test burn data for the Basin F waste and the available data from operating hazardous waste facilities.

Page 5A-5; Table 5A-3: Since the Basin F liquid has a high density (ca. 1.3), mg/L is not equivalent to ppm by weight.

Response: WESTON converted the concentrations received from μg/L and mg/L to ppm by wt. based upon a density of 1.24 gm/mL (based upon data collected by Woodward-Clyde Consultants in 1988). The table will be corrected to show ppm by wt.

$$\left(\frac{tons}{yr}\right) = [ppm\ by\ wt\ \left(\frac{\mu g}{gm}\right) = \frac{\frac{\mu g}{L}}{1.24\frac{gm}{ml}\times 10^3\frac{ml}{L}}] \times \frac{10{,}325\frac{lb\ of\ waste}{hr}\times 453.6\frac{gm\ of\ waste}{lb\ of\ waste}\times 7{,}000\frac{hrs}{yr}}{453.6\frac{gm\ of\ pollutant}{lb\ of\ pollutant}\times 10^6\frac{\mu g}{gm}\times 2{,}000\frac{lb\ of\ pollutant}{tons\ of\ pollutant}}$$

Page 5A-21 & 23; Table 5A-10 & 12: I was unable to derive the uncontrolled emission values from the present data and equations. Also in the two last columns labeled "Maximum Emissions" the conversion from lbs/ton to lbs/hr apparently was based on a burn rate of 10,280 lbs/hr as opposed to the burn rate expressed in note 1 of 10,325 lbs/hr. In Table 5A-12 the apparent burn rate was 10,347 lbs/hr. Small differences, but the calculations should be consistent. Also, the uncontrolled Emissions column should be corrected for days/yr burning as this is a property of waste. Was the Test Burn data also corrected for days/yr? If not, they are not equivalent. If the last column (lb/hr) is to be an annual average then it should be so noted.

Response: WESTON used 10,325 lbs/hr for all throughput calculations. Rounding differences can account for the different results (the emission factors shown in Tables 5A-10 and 5A-12 are rounded). The table below shows the differences resulting from rounding. The emission factors and results are multiplied by 10^{-3}.

Table No.	Metal	Emission Factor (lb/ton)	Fluor Daniel		WESTON	
			Throughput (lb/hr)	Results (lb/hr)	Throughput (lb/hr)	Results (lb/hr)
5A-10	Aluminum	0.0998	10280	0.513	10325	0.515
	Antimony	0.351	10280	1.804	10325	1.812
5A-12	Aluminum	1.38	10347	7.139	10325	7.124
	Antimony	0.0746	10347	0.386	10325	0.385

Also, the footnote (1) on Tables 5A-10 and 5A-12 states that the emission factors are based upon 7,000 hr/year. Therefore, the operating hours take into account the number of scheduled operating days.

Page 5A-24: The stated stack specifications (height, base elevation, temperature, flowrate, and plume rise) do not appear to be consistent and may not relate to conceptual design specifications. If the terrain-adjusted height is -22 m., (The incinerator is in a valley) then a different air model (perhaps Complex I) should be used. These are important points as they materially affect the projected ambient air concentrations.

Response: The stack specifications, except plume rise, were used in all models. The plume rise discussed in the first draft of Appendix 5A was based upon the EPA Tier I/Tier II screening procedures. For complex terrain in rural areas, this procedure is based on COMPLEX I, as recommended by U.S. EPA. The Tier I/Tier II values are derived from the results of Complex I runs for 9 facilities located in complex terrain, and took into account the stack specifications, the plume rise, the meteorological data, and emissions relative to ambient concentrations. The terrain-adjusted stack height calculation is one step in the EPA Tier I/Tier II screening procedure.

The text will be modified to clarify that the Tier I and II methods were used to determine worst case emission rates for selected pollutants for which other test data were unavailable.

Page 5A-25; Table 5A-13: Again, unable to calculate expected feed rates based on average values in Table 5A-3. It looks like a waste feed rate of 10,292 lb/hr.

Response: The waste feed rate of 10,325 lb/hr and the waste analyses data were provided to WESTON and were used to develop the individual waste component values in Table 5A-3 and, subsequently, the pollutant emission rates. Table 5A shows the emission rates expected to be incinerated over a year. As noted previously, all numbers shown in the tables are rounded; while the calculations are based upon several significant digits. As an example, the emission factors for antimony and barium (from Tables 5A-10 and 5A-12) and results (from Table 5A-13) are multiplied by 10^{-2}.

Table No.	Metal	Emission Factor	Fluor Daniel		WESTON	
			Throughput (lb/hr)	Results (lb/hr)	Throughput (lb/hr)	Results (lb/hr)
5A-10	Antimony	0.12	10292	0.618	10325	0.620
	Barium	0.23	10292	1.184	10325	1.187
5A-12	Antimony	0.18	10292	0.926	10325	0.929
	Barium	0.23	10292	1.184	10325	1.187

Page 5A-28; Table 5A-15: Using the maximum of the average and the maximum for the likely and worst cases respectively, does not keep within the spirit of the RME approach. This is particularly true when the maximum may be not be related to the predicted incinerator operations. If the maximums are used, then which maximum should be identified. My preference would be to use the test burn data and compare it to the emissions based on the 95% confidence limit of the average waste stream analysis. The EPA Tier guidance emission rates can then be used to examine for reasonableness.

Response: The raw data were not available for the various waste stream analyses. For each analysis, either a single value or a range was provided. Therefore, 95% confidence limits of the data could not be calculated. Because of the small number of data points and the uncertain and variable basis of the value used to represent each analysis, no statistical analyses could be performed on the waste stream analysis data. Therefore, using the "maximum of the averages" (where the "average" is the arithmetic mean of the single value for a set of analyses or the average of the endpoints of the range for the set of analyses, for all of the data sets in the group (i.e., for the basin, tank, or pond)) is the most conservative reasonable upper bound approach available.

Also, during the test burn, many of the test runs were not at normal conditions and the proposed facility is not expected to have these difficulties (as explained in Tables 5A-1 and 5A-2). Therefore, many of the runs could not be used. Only two test runs for dioxin and one test run for metals were acceptable. These data were used for development of base case emission estimates; however, because of the small number of data points, confidence intervals could not be calculated. WESTON used all the data which were available (acceptable and unacceptable) to take a conservative approach to develop the sensitivity case emission factors. This was necessary to develop a "worst case" risk for individuals in the area. Where appropriate, the discussion in the revised document was clarified.

Appendix 5B: A review of Appendix 5B revealed another discrepancy in feed rates. The attached table (not included in this response) illustrates the calculations based on the maximum average concentration from Table 5A-3 for two compounds. A best guess is that the sp. gr. of the liquid was not taken into account to arrive at Dr. Dellinger's analysis.

If I understand Dr. Dellinger's narrative correctly, it appears that a DRE of 99.99% for toluene must be achieved for these emission rates to be applicable and then 99.9999% will be achieved for a majority of the other compounds. This may be very difficult to prove because with a toluene emission rate of 2.54 E-09 g/sec and a stack flow rate of 7.3 m^3/sec the predicted toluene concentration in the stack gas will be 3.48 E-04 $\mu g/m^3$. Measurement of this concentration is not likely achievable with most analytical protocols. At the predicted (non-normalized) emission rate of 1.02E-05 g/sec (3.54E-04 tons/yr) the stack gas concentration will be 1.39 $\mu g/m^3$ which is at most detection limits.

This is an area that I am not comfortable in rendering an opinion but I think a more conservative approach might be to use as emission rates Column H of Dr. Dellinger's report. It is possibly a more realistic approach. At least these numbers may be verifiable during stack testing.

Response: WESTON converted the concentrations provided as $\mu g/L$ or mg/L into ppm by weight, based upon a density of 1.24 gm/ml, and subsequently into emission rates (tons/year). As noted previously, the values used by Dr. Dellinger do reflect the density of the liquid and are correct.

As discussed in a conference call with Dr. Dellinger on 9 April 1991, the values in Column H of Dr. Dellinger's spreadsheet are based on the relative incinerability results of his laboratory studies. Thus, the effective theoretical destruction efficiencies in Column H are also semi-quantitative relative values. Therefore, Dr. Dellinger normalizes the DRE's to develop a quantitative DRE and emission value. Since the facility is only proposed and not yet operating, and because a trial burn will have to be conducted, Dr. Dellinger assumes that one of the compounds most difficult to destroy will be one that will be selected as a POHC for the Trial Burn and, thus, demonstrated to be destroyed with a DRE of 99.99%. The DREs of the other compounds are then normalized relative to a DRE of 99.99% for the selected compound. Based on recent discussions, it was agreed that Dr. Dellinger's methodology was valid. Two alternative normalization techniques were recommended by the State of Colorado's Contractor and were considered:

- Use of test burn DRE results for carbon tetrachloride or other organic compounds as the basis for normalization.

- Assuming that the normalized DRE can not exceed some value such as 99.99% or 99.999%.

The use of test burn DRE results was considered; however, there are several reasons why the test burn data, which were available only for carbon tetrachloride, were not assured as suitable. First and foremost, the test burn data were from a pilot scale rather than full scale facility. Second, there were repeated operating problems during testing. For example, the feed nozzles clogged frequently and were cleared by rapping or by using steam. This problem caused frequent atypical combustion conditions, as indicated by high carbon monoxide levels (indicative of incomplete combustion). The times of these abnormal

operating conditions were reported for the emission tests measuring dioxins/furans and metals; however, they were not reported for the emission tests measuring carbon tetrachloride destruction efficiency (DE). Therefore, no judgment can be made regarding the validity of any of the DE testing. Finally, the test burn was conducted with only the supernatant of a sample from Basin F rather than the entire waste. Considering these three factors alone, the validity of the pilot test burn for determining a representative DRE of carbon tetrachloride is quite questionable.

The second approach of limiting the normalized DRE to a maximum value was used in the revised analysis. Although this approach is considered extremely conservative, the DRE was limited to a maximum of 99.99% for all organic waste feed components (POHCs). The unnormalized PIC emissions estimated by Dr. Dellinger were also used in the revised analysis.

Page 5-10: As a general point, the multiple feed rates appear to arrive because the incinerator feed rate is based on 1,000 gal/hr and not lbs/hr. Therefore, variations in the assumed sp. gr. will change the feed rate in lbs/hr and hence the DRE and emissions calculations will vary. For the purpose of emissions calculations either calculate input based on volume and concentrations based on volume, or specify a sp. gr. (The Army has used 1.3 gm/cm^3).

Response: WESTON converted the concentrations from the raw data in $\mu g/L$ and mg/L to ppm by weight based on a density of 1.24 mL (as noted in response to previous comment) and calculated waste component feed rates based on an incinerator feed rate of 10,325 lb/hr.

Page 6-1 Section 6: All modeling parameters should be presented in the main body.

Response: All modeling parameters will be presented in tables in Section 6 of the document.

Page 6-2 Section 6.2 Bullets: Will stack downwash be considered. Based on terrain correction info presented in appendix 5A, it should be presented.

Response: Stack tip and building downwash were utilized in the dispersion and deposition model. Terrain elevations for each receptor was determined through an extensive review of the USGS topographic maps of the RMA area.

Page 6-2 Figures 6-1,-2,-3,-4: The potential receptor locations should be presented on these maps. If some discussion as to patterns of dispersion and deposition could be made, it would be helpful.

Response: The potential receptor locations will be presented in Section 8, using the same base map as used for Figures 6-1, 6-2, 6-3, and 6-4. The text in Section 8 will also include a discussion of the patterns of dispersion and deposition.

Page 6-15 Table 6-1: The ground level concentrations of both vapor and particulate for all scenarios including Engineers Lake should be presented. Previous data from earlier sampling programs should be presented either as background or for comparison.

Response: Ground level concentrations were assumed to include both vapor and particulates and are presented in Table 8-2 for all scenarios. Total deposition rates are presented for each exposure scenario in Appendix 8A. Total deposition rates over Engineers Lake are presented in Appendix 7A (Table 7A-3). Background or previous sampling results will not be used as comparison for the predicted concentration or deposition values since the intent of the risk assessment is to showing the monumental risk above background due to the operation of the SQI.

Page 7-5 last paragraph of Section 7.3: I question this rather severe assumption that all volatiles, all metals, and semi-volatiles will both be examined as totally in the vapor phase for the inhalation pathway and as totally absorbed on particulates for the deposition pathways. This section is in contradiction to Section 7.4.2 where the volatiles were eliminated from the deposition pathway. Some partitioning could be assumed.

Response: As discussed in Subsection 7.4.2, volatiles are assumed to only be available for inhalation, and not for deposition. This will be clarified on page 7-5. Currently, available information on partitioning between the vapor phase and particulates is poor, and not conclusive. Since there is so much uncertainty associated with these data, we have chosen to be conservative, and have assumed that all semi-volatiles and metals are available for inhalation as well as deposition.

Page 7-10 Table 7-2: The background soil concentrations should be based on local data, and, whenever possible, be based on data from soils having similar geological characteristics.

Response: Background soils data for Rocky Mountain Arsenal are available for on-post and off-post locations. These will be incorporated into the document upon receipt of those data.

Page 7-10 Table 7-2: I would select the metals Barium, Copper, Mercury, Selenium, Sodium, and Thallium as metals of concern for the deposition pathway. Even though the metals Arsenic, Chromium, Lead, etc. are potential carcinogens, the predicted depositions will not add significant amounts to the native soils.

Response: We include all carcinogens in our evaluation of risk. Because of the assumed no threshold effect for carcinogens, carcinogens always pose some risk. In addition, carcinogens should not be eliminated based on background, because background risk could already be high. Therefore, a situation arises where a chemical that is eliminated may be one of the highest risks for the incinerator.

Page 7-14 first paragraph: This paragraph is somewhat contradictory. Where all contaminants were excluded, but Table 7-5 says not.

Response: Tier 1 water concentrations were calculated for all semivolatiles and metals for purposes of screening the contaminants. Based on the Tier 1 screening results, Tier 2 water concentrations were calculated and used in the risk assessment. This will be clarified.

Page 7-16 next to last paragraph: The EPA Lead Biokinetic model should be used.

Response: This model will not be used. The Army was advised by Dr. Chris Weis of EPA Region VIII that this model is inappropriate for use at this site.

Page 8-2 bullets: As previously stated, these scenarios should be presented with the isopleths. Perhaps these receptors should be presented earlier. In addition, Engineers Lake is a separate receptor and should be listed as such.

Response: The receptor locations will be placed on a map in Section 8. Page 8-2 lists the four potential RMEI scenarios. Engineers Lake will not be listed here because it is not a scenario. It was included in three of the four scenarios for evaluation of the fish ingestion pathway.

Page 8-6 Table 8-1: Each exposure scenario should represent total exposure to all contaminants by all routes. This may be true because of the earlier assumptions that particulates will carry all contaminants or that all contaminants will be in the vapor phase. If this is so, then the reader should be reminded.

Response: We will state on this table that inhalation includes both vapor and particulate matter.

Section 8: It would be my preference that all formulas, calculations, and assumptions be presented in the main body of the text. If the size becomes a problem, then maybe the report could be divided into an Emissions Volume and a Risk Volume. While not essential, it would be helpful to keep the exposure abbreviations the same as in the RAGS.

Response: The general format of the report was not be changed; however, all of the formulas in the appendix were referred to in the main body of the text. In addition, where appropriate, the exposure abbreviations will be changed to match those in RAGS.

Page 8-52 Table 8-11: This table belongs on page 8-27 prior to the presentation of the daily intake values.

Response: This table will be moved before the tables that present daily intakes.

SECTION 3

RESPONSE TO COMMENTS FROM THE STATE OF COLORADO ON THE DRAFT HUMAN HEALTH RISK ASSESSMENT (JANUARY 1991) FOR ROCKY MOUNTAIN ARSENAL INCINERATION PROJECT

GENERAL COMMENTS

Comment No. 1:

The State appreciates the opportunity to comment on this document at this time. Although the Human Health Risk Assessment for the Basin F Liquid Incineration Project ("Risk Assessment") is premature in that necessary emission data will not be available until after the trail burn is conducted and results analyzed, review by the parties at this stage of the process is essential to facilitate consensus on the approach to be taken, and to identify potential areas of concern.

One of the areas of concern identified by the document is the contribution of inorganic emissions, particularly selenium, to the total risk posed by the incinerator. Based upon this information, the Army should undertake an investigation of alternatives to reduce these emissions. Alternatives could include such things as the installation of additional equipment or improved operating conditions.

Response:

The risk assessment was not premature in that the purpose of a preconstruction risk assessment is to determine whether the health risk resulting from the proposed facility will be acceptable so that decisions can be made regarding modification of the design and whether the facility should be built. These decisions must be made before the facility is built and, therefore, cannot be made after the trial burn is conducted.

The bases of the estimate of selenium emissions were rechecked. A data entry error in unit conversion was discovered for selenium and several other compounds. These errors will be corrected in the revised health risk assessment. Selenium emissions will be reduced by a factor of 1,000. Therefore, the consideration of additional control equipment beyond the proposed state-of-the-art controls will not be necessary.

Comment No. 2:

As noted by the EPA in its comments dated 11 March 1991, the Risk Assessment does not reflect the mandate of the National Contingency Plan or the agreement of the parties to

calculate reasonable maximum exposures (RMEs). There is little point in calculating a "sensitive case" if the assumptions underlying such an analysis are implausible. It is not clear that the "base case" reflects the 95th percentile of exposure; therefore, exposure assumptions reflecting RMEs must be designated and agreed upon by the parties and incorporated into later iterations of this document.

Response:

Incinerator risk assessments differ in certain respects from Superfund risk assessments (e.g., predicted emission rates instead of empirical data); therefore, because of these differences and the associated limitations in data availability, it was not possible to calculate the RME as defined under Superfund. In terms of *Risk Assessment Guidance for Superfund* (RAGS; EPA, 1989), "Reasonable Maximum Exposure" (RME) was not appropriately defined in this report, and WESTON agrees to the comment. WESTON will better define the estimates of emissions and exposure that were employed in this risk assessment and their relationship to the RME.

WESTON attempted to be reasonable when it came to specific information available on exposure, but had to make conservative assumptions when data were lacking. As discussed below, both base case and sensitivity case predicted emissions were evaluated since we could not calculate an upper 95% confidence level as previously discussed in the responses to comments of EPA and ITO (and discussed below). To be more representative of Superfund Guidance, the RME is "best" identified by base case emissions, even though base case does not represent upper 95% confidence limits. Also note that we used predicted "average" and "maximum" soils data in various procedures, further complicating the definition of the RME. These "average" and "maximum" soil concentrations are based on soil contaminant concentrations expected over a 70-year period, and are affected by such processes as deposition and degradation. Since, in this risk assessment, deposition over a 2-year period was evaluated and degradation was not considered, the collected average and maximum concentrations over a 70-year period are very similar, and only differ by a factor of 1 to 2%.

Both the base and sensitivity case emissions were used in assessing risk in this report since there were an insufficient number of data points with which to calculate an upper 95% confidence level of emissions. For most contaminants, these data consisted of the results of sets of waste analyses (a set of samples taken from the same container by one agent at the same time), which were presented either as ranges (with no individual data points) or single data points (that may be calculated averages or the only measured values). The arithmetic mean of the midpoints of the ranges and the single data points from one group of data sets (a group of all the sets taken from the same container, i.e., basin, pond, or tank) were compared and the highest of these values were used for the base case emission rate of each compound. This approach is believed to be a reasonably conservative method of calculating a conservative upper bound of continuous (long-term) emissions in lieu of calculating an upper 95% confidence level of emissions. However, due to the uncertainty associated with estimating these emission rates, a sensitivity case, or worst case estimate of emissions, was also evaluated. The sensitivity case emissions were estimated by

comparing the upper end of the ranges and the single data points and using the highest values for each set and group of sets. The sensitivity case is designed to represent the absolute worst case of continuous, long-term emissions or the peak short-term variations in emissions.

For organics other than dioxins/furans, the selected wastestream values were used as inputs to Dr. Dellinger's analysis that estimated emissions. For metals, EPA estimates of volatilization and control efficiency were used. Test burn data were considered in the development of base and sensitivity case emissions estimates for measured metals and dioxins/furans. The acceptable test burn data points are not sufficient to calculate meaningful confidence intervals.

Comment No. 3:

On Page ES-12, it is explained that chronic RfDs were used for all routes of exposure even though inhalation exposure will only occur over 2 years. It would be more appropriate to use subchronic RfDs for the inhalation pathway (see Risk Assessment Guidance for Superfund, Section 7.2, Pages 7-5 to 7-6).

Response:

The approaches suggested by EPA regarding the calculation of subchronic and chronic hazard indices are highly simplified and do not take into account all possible exposure situations. Although an individual may be subchronically exposed to contaminants through inhalation, they are chronically exposed to the same contaminants through ingestion and/or dermal absorption. Depending on the chemical, the toxic effect(s) through inhalation may or may not be additive to the effect(s) through the other exposure routes. If a separate subchronic hazard index were calculated for inhalation, the possible additive effects of some chemicals would not be taken into account.

To keep the approach to risk characterization as simple as possible, and while ensuring that the possible additive effects through different exposure routes were not overlooked, the doses calculated through all exposure routes were conservatively compared to chronic RfDs and the hazard quotients for all exposure routes were added. In the base case, even this conservative approach did not indicate a potential for noncarcinogenic health risks.

Comment No. 4:

Dr. Dellinger's analysis of organic emissions contains several flaws:

a. He does not support his methodology for normalizing and predicting emission rates with any experimental data from incinerators. The papers which he cites in support of this work, (those cited as #6 and #7 in his list of references) recommend that the prediction

of the relative destructivity of organic compounds be used for ensuring that the POHC which is chosen for the test burn is the most stable, and the most likely to ensure the optimum operation of the incinerator. The work which Dr. Dellinger presents here should be used only for the purpose of choosing toluene as the POHC for the test burn of this incinerator, not to estimate emissions. We would prefer that, rather than estimating the expected emissions from the incinerator using his methodology, actual emission rates be measured in the trial burn. We realize that it may not be practical to measure the emission rates of all compounds that are likely to be emitted from the incinerator during the trial burn. We recommend that the Army investigate what has been done to estimate emissions for risk assessments conducted for other incinerators. The state will also continue to try to develop alternate methods for estimating incinerator emissions from limited data.

b. Dr. Dellinger recommends, in the first paragraph on Page 5B-2, that when potential emission rates from the incinerator are available, they would be used as the basis for emissions estimates. The test data from the pilot testing of Basin F Liquid in a Submerged Quench Incinerator at Conshohocken, PA, indicates that the DRE for the chosen POHC, carbon tetrachloride, was 99.9987%. If this number is used as the basis for normalizing the emissions using Dr. Dellinger's methodology, the DRE for toluene would be less than 90%. The estimate of the DRE for other organic compounds would be similarly affected. If Dr. Dellinger's approach is to be used, all of the emission rates should be recalculated based on the measured DRE of carbon tetrachloride.

Moreover, since carbon tetrachloride was spiked at a high concentration in the feed, it should be assumed that the emission rate was due to its emission as a (in Dr. Dellinger's terminology) POHC only. Because those precursors which form carbon tetrachloride as a PIC were not spiked proportionally in the incinerator feed during the pilot test, the amount of carbon tetrachloride emitted due to PIC formation is insignificant compared to the amount emitted as a POHC. The emission rates for the organics other than carbon tetrachloride should be normalized to carbon tetrachloride, assuming an effective theoretical DRE of 99.9999% (Dr. Dellinger's theoretical DRE assuming that carbon tetrachloride is not emitted as a PIC) and an actual DRE of 99.9987% (the measured DRE in the pilot test). New data collected in the trial burn, should be used to update the estimates of emission rates when available.

Response:

a. As was explained in the conference call with Dr. Dellinger (telephone conversation report attached in Section 5 of this report), Dr. Dellinger's approach for estimating organic emissions is used for two major reasons. First, as noted in the comment, it is not practical to measure all compounds in the trial burn both because of analytical cost constraints and because of the compounds that would be present at levels below their detection limit. More importantly, the purpose of a preconstruction risk assessment is to determine whether the health risk resulting from the proposed facility will be acceptable so that decisions can be made regarding modification of the design and

whether the facility should be built. These decisions must be made before the facility is built or else their purpose would be defeated. Therefore, the risk assessment can not be made after the trial burn has been conducted. However, as noted by Dr. Dellinger, the risk assessment can be rerun after the trial burn to ensure that the health risk based upon the measured emissions is also acceptable.

The results of Dr. Dellinger's analysis can, and often are, used to select the most appropriate POHCs for a trial burn. Generally, the constituents of the waste stream that are expected to have the greatest thermal stability would be recommended. As noted in the comment, Dr. Dellinger has appropriately suggested that basing POHC selection on his analysis is more likely to ensure the optimum operation of the incinerator.

A preliminary investigation was made of the various approaches used to estimate emissions from other hazardous waste incinerators. Dr. Dellinger's approach has been used for a number of facilities other than Dr. Dellinger's, one of the most common approaches used in the past was to select a small number, typically a dozen or fewer, of compounds that were of concern for risk assessment and to estimate worst case emissions based on assumptions regarding usage of the compounds and their control. This approach of selecting a few compounds possibly not present in the waste stream is no longer acceptable to the EPA because it does not provide an estimate of the actual risk from the expected waste stream of the proposed facility. Therefore, EPA prefers estimates such as Dr. Dellinger's that are based on the actual waste feed rather than on emissions data from other incinerators burning substantially different waste.

b. As stated in the comment, Dr. Dellinger does recommend using actual emission rates, when available, to normalize his analysis; however, there are several reasons why the test burn data are not assured to be suitable. First, the test burn data are from a pilot scale rather than full scale facility. Second, there were repeated operating problems during testing. For example, the feed nozzles clogged frequently and were cleared by rapping or by using steam.

This nozzle clogging caused frequent atypical combustion conditions, as indicated by high carbon monoxide levels (indicative of incomplete combustion). The times of these abnormal operating conditions were reported for the emission tests measuring dioxins/furans and metals; however, they were not reported for the tests measuring carbon tetrachloride destruction efficiency (DE). Therefore, no judgement can be made regarding the validity of any of the DE testing.

Finally, the test burn was conducted with only the supernatant of a sample from Basin F rather than the entire waste. The potential effect on DE cannot be quantified. Considering these three factors alone, the validity of the pilot test burn for determining a representative DE of carbon tetrachloride is quite questionable. Therefore, it is considered inadvisable to use the carbon tetrachloride DE results from the test burn as

the basis of normalizing Dr. Dellinger's analysis of destruction efficiencies and emission rates.

Of course, as noted in the comment, measured emissions data from the trial burn can be used to calculate emission rates for the measured compounds and to revise the normalization of the remaining organic compounds. These revised emissions data could be used to update the risk assessment after the trial burn of the operating full-scale incinerator.

Comment No. 5:

The Risk Assessment includes a degradation factor to account for the degradation of organic compounds in soil. The methodology which was used is summarized in Appendix 8A. The degradation rates were taken, where available, from soil half-life values for individual compounds given in Volumes II and III of the on-post Human Health Exposure Assessment. The Risk Assessment assumes that the compounds degrade into innocuous products which do not present any further risk to human health. This assumption is not supported. The Risk Assessment also does not account for the fate of those compounds which leave the soil but may present a hazard to human health as a vapor. The EPA has recently commented on the use of degradation factors in the On-Post Endangerment Assessment in a letter from Connally Mears to Kevin Blose, dated March 5, 1991. Mr. Mears states:

> EPA's potential concurrence with incorporation of the degradation factor is dependent upon specific identifications of individual degradation products, identification of toxicity data specific to degradation product, and performance of the degradation product Risk Assessment.

Similarly, if degradation is to be taken into account in this Risk Assessment, the risks associated with the degradation products and the fate of compounds which leave the soil but do not degrade must also be evaluated. In the absence of toxicity data on degradation products, the environmental stability of known toxicants should be deemed infinite.

Response:

Since there are insufficient data with which to evaluate all of the potential degradation products of organic in soil, degradation will not be evaluated for any chemical in the next draft. It will be assumed that all compounds are environmentally stable and will persist for the lifetime of the facility.

Comment No. 6:

This risk assessment does not account for the presence of hydrazine and related compounds in the Basin F Liquid, despite the information given on Pages A-44 to A-56 of the

Assessment of CERCLA Hazardous Substances Released by Shell Oil Company and the United States Army at the Rocky Mountain Arsenal, Volume I, which indicates that approximately 7,400 pounds of hydrazine and 40,700 pounds of unsymmetrical dimethyl hydrazine (UDMH) were discharged into Basin F. Recently obtained air monitoring data from the Basin F units have indicated detections of NDMA; therefore, we cannot ignore its presence or the presence of other hydrazine-related compounds. The Army must re-analyze representative samples of the Basin F liquid to identify and quantify characteristic ions of hydrazine and related compounds at the appropriate retention times. In the event that analysis fails to detect these substances as a result of interference from other compounds, some worst-case assumptions must be made.

Response:

The Army performed an analysis on the risks associated with incinerating hydrazine rinsewater as an addendum to the HHRA (Volume III, Final Draft). This addendum cites the hydrazine rinsewater that is to be added to the Basin F liquid, and it will be assumed that the risk of exposure to hydrazine and its derivatives will be additive.

The document to which the State refers presents a worst case estimate, and even claims that the levels of UDMH are almost certainly much lower than what is listed. Also, in the analysis of Basin F liquid, no indication of any hydrazine-related compounds was found. This seems to substantiate the likely scenario that the compounds have broken down and are no longer present in their original form. Due to this, it is believed that the analysis performed on the hydrazine rinsewater is suitable for determination of the effects of any hydrazine-related compounds in the Basin F liquid.

SPECIFIC COMMENTS

Comment No. 1:

Page 6-6: Please provide the values of the input parameters used for the air model, including mass particle size distribution, the surface roughness coefficient for the receptors, and the stack height, gas velocity and gas temperature.

Response:

This information will be included in Section 6 of the final draft document.

Comment No. 2:

Page 5A-17, Second full paragraph: It is stated that the calculations for metals emissions based on the concentrations in the feed is given in Table 5A-9. They are actually given in Tables 5A-10 and 5A-12.

Response:

As pointed out in the comment regarding Page 5A-17 second paragraph of the draft document, the calculations for metals emissions based on the concentrations in the feed were incorrectly stated to be given in Table 5A-9. The base case emissions are actually given in Table 5A-10 (as stated in the last paragraph on Page 5A-20, the sensitivity case emissions estimates were presented in Table 5A-12. The reference for the base case was corrected in the revised document.

Comment No. 3:

Table 5 beginning on Page 6A-60: We have the following comments on the exposure parameters summarized by the Army in this table:

a. The soil ingestion rate for the maintenance work should be the same as the RME in the HHEA for the industrial or commercial worker, i.e., 100 mg/day.

b. The skin surface area for a maintenance worker should be the same as the RME in the HHEA for the industrial worker, i.e., 3200 cm^2, which represents exposure of head, neck, forearms, and hands.

c. The skin surface area for the resident adult and the farm household adult should be the same as recreation and casual visitors RME in the HHEA or 4,500 cm^2, which represents one-half of the head, both hands, forearms, and lower legs.

d. The skin surface area for the resident child and resident farm household child should be the same as the RME in the HHEA for the recreational or casual child visitor, i.e., 2,500 cm^2, which represents exposure to the head, neck, hands, feet, and lower arms.

e. The soil adherence factor for the maintenance worker and the farm household adult should be the same as the RME value in the HHEA for the industrial worker, i.e., 1.5 mg/cm^2.

f. The soil matrix factor should be the same as for the RME in the HHEA, i.e., 1.0.

g. The exposure frequency for dermal contact seems low. Please provide underlying assumptions, criteria and literature references supporting the selection of these parameters.

h. An HLA report is cited as the basis for the percent vegetables homegrown exposure parameter; however, a full reference is not given. Please provide a full reference.

i. An unspecified HLA report is again cited as the source of the fish ingestion rate. The value given is much lower than the 95th percentile value given in the Exposure Factors Handbook, i.e., 32.1 g/person/day versus only 4.84 g/person/day. Please use the Exposure Factors Handbook value, or justify the deviation.

Response:

a-f: All of these exposure assumptions will be incorporated into the next draft of the document to be consistent with previous report. However, we feel that some parameters for the suggested skin surface values are overly conservative; for example, for the adult resident and farmer, it is not likely that exposed surfaces would include legs for two-thirds of the year. Also, it is likely that the adult resident would have less dermal exposure than the adult farmer.

g: The underlying assumptions for dermal contact exposure frequency are provided in Section 8. Dermal exposure frequency was based on the assumption that the farmer, worker, and child resident would spend 5 days/week outside and the adult resident would spend 3 days/week outside, during the warmer two-thirds of the year (i.e., 35 weeks). These values were based on what seemed to be reasonable assumptions. No references are available.

h&i: All exposure assumptions are summarized in Section 8, where references and bases for the assumptions are also provided. The HLA report should have been referred to as "ESE et al." in Appendix 6A. This is one of the three reports listed on Page 8-7 with which WESTON was to be consistent with in developing exposure assumptions. The reference is as follows:

ESE (Environmental Science & Engineering, Inc.) Harding Lawson Associates and Applied Environmental, Inc. 1989. *Technical Support for Rocky Mountain Arsenal. Offpost Operable Unit Endangerment Assessment/Feasibility Study with Applicable and Appropriate Requirements. Volume I. Draft Final Report.* Version 2.1. March 1989. Contract No. DAAA15-88-D-0021.

Comment No. 4:

Page 7A-4. The sensitivity case emission rates for the organics given in the first column of Table 7A-1 do not correspond to the emission rates given in Table ES-1. There is no sensitivity emission rate for organic compounds, and the value given does not equal the base case emission rate for the organic compounds.

Response:

This error will be corrected in the final report.

Comment No. 5:

Page 8A-3: The State has the following comments on the half-life values presented on this page.

a. Although not explicitly stated, we assume that the Army has taken the half-life of those compounds which were not listed on page, to be infinite, i.e., there is no degradation of these compounds. Please state this clearly.

b. The half-life for endrin, according to the HHEA, is "upwards of 10 years." Since this means that the half-life exceeds 10 years, it is incorrect for the Army to use 10 years as the half-life for this compound.

c. There is no half-life for DDE given in the HHEA. Please provide a reference for this value.

d. The value for the half-life of DDT, according to the HHEA, is between 3 and 15 years. Because of the high degree of uncertainty associated with these values, it is incorrect for the Army to take an average. The maximum value should be used.

Response:

No soil half-lives will be used, since degradation of organics in soils will not be evaluated (see Response to General Comment No. 5). This will be clearly stated where appropriate.

SECTION 4

CITED REFERENCES

EPA (U.S. Environmental Protection Agency). 1989a. Risk Assessment Guidance for Superfund. Human Health Evaluation Manual - Part A. Interim Final Office of Solid Waste and Emergency Response. Washington, DC. OSWER Directive 9285.7-Ola.

EPA (U.S. Environmental Protection Agency). 1989b. Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites. OSWER Directive # 9355-4-02. September 1989.

EPA (U.S. Environmental Protection Agency). 1989c. Guidance on Metals and Hydrogen Chloride Controls for Hazardous Waste Incinerators. Volume IV of the Hazardous Waste Incineration Guidance Series.

EPA (U.S. Environmental Protection Agency). 1990. Methodology For Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions. Interim Final. Environmental Criteria and Assessment Office. Cincinnati, OH. EPA/600/6-90/003.

Weiss, Christopher P. 1991. Personal Communication. U.S. Environmental Protection Agency, VIII, Denver, CO.

WESTON (Roy F. Weston, Inc.), 1991a. Air Toxic Emissions from Municipal Hazardous and Medical Waste Incineration and the Effect of Control Equipment. Siebert, P.C. and Alton, D.R. # 91-103-15.

Woodward-Clyde Consultants. 1990. Final Decision Document for Interim Response Action, Basin F Liquid Treatment, Rocky Mountain Arsenal, Volume I-Text. May 1990. Contract No. DAAA15-88-D-0022/0001.

SECTION 5

DOCUMENTATION

PHONE CONVERSATION RECORD

Name: Dr. Barry Dellinger — Date: April 9, 1991

Company: Univ. of Dayton Research Inst. — Time: 2:00 pm

Other Participants:
Ben Wachob - RMA
Janet Yanowitz - Geotrans
Larry Diede - U.S. EPA
Lou Militana - WESTON

Originator: Paul Siebert - WESTON

Phone: (513) 229-2846 — W.O. No. 3886-44-01

Subject: Organic Emission Estimates for Rocky Mountain Arsenal Basin F Incinerator

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Janet stated that she had two major problems with Dr. Dellinger's analysis as presented in Appendix 5B of the Health Risk Assessment for the Rocky Mountain Arsenal Basin F Waste Submerged Quench Incinerator. First, the destruction and removal efficiency (DRE) was assumed to be independent of the concentration of the individual principal organic hazardous constituent (POHC). Second, the destruction and emissions could be normalized using the DRE measured for carbon tetrachloride during the February 1989 test burn.

Dr. Dellinger replied that the study by Trenholm et al. (1985), which Janet had cited as the basis for her first comment, examined the relationship of DRE and various parameters for eight full-scale hazardous waste incinerators. The only correlation found was with concentration. This apparent finding was a major impetus in Dr. Dellinger's developing his estimation method because the correlation with concentration (1) did not consider the contribution of products of incomplete combustion (PICs) to emissions and (2) did not reflect that the concentrations of the individual POHCs were all so low compared to the total amount of organics that they could not have a significant effect on the reaction kinetics. Dr. Dellinger also noted that it is very difficult to obtain a meaningful correlation from test results at a number of full-scale facilities because of the various parameters that can differ and may not be observed or quantified during testing.

In response to the problems with correlations noted above, Dr. Dellinger developed his approach of estimating destruction and emissions based on a ranking of thermal stability, including the normalization technique noted in Janet's second comment. His spreadsheets are based on thermal destruction efficiencies (DE) [Column D] that are semi-quantitative relative values developed

from the relative incinerability results of his laboratory studies. Thus, the effective theoretical destruction efficiencies [Column H] are also semi-quantitative relative values. Therefore, these data must be normalized with measured data in order to calculate truly quantitative values. When he first developed the technique, Dr. Dellinger intended to normalize based on the trial burn results for the actual full-scale facility. However, this approach can not always be used for two reasons: some operating facilities have not had trial burns and proposed facilities can not have a trial burn since the facility has not been constructed or operated. Therefore, Dr. Dellinger assumed that a DE of 99.99% would have to be demonstrated in a subsequent trial burn for the most difficult to destruct potential POHC. This approach gives the best estimate of emissions from a proposed facility.

Dr. Dellinger noted that, technically speaking, his model can be normalized or calibrated with any number of actual data points that may be available. His model does consider both POHCs and PICs. He maintains a large file of literature upon which he bases his thermal destruction and PIC formation estimates. He considers both PICs formed from potential reactions of specific precursors and those of non-specific precursors (based on trial burn emission test data). In general, he estimates as conservatively high as he considers to be possible. Dr. Dellinger that recent testing of full-scale hazardous waste incinerators by Accurex and MRI for the U.S. EPA confirmed a correlation of emissions with his thermal stability ranking. These tests also confirmed the presence of the PICs he had predicted.

At the close of the discussion, Janet said she was convinced of the validity of the general methodology. However, she still thought that the analysis should take the carbon tetrachloride test burn data into account and stated that the Colorado comments would reflect that opinion. WESTON replied that the test burn data would be reevaluated to see if the carbon tetrachloride DE data were useable.